Veusz - a scientific plotting package

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Table of Contents

1. Introduction 1
    - Veusz 1
    - Terminology 1
        - Widget 1
        - Settings: properties and formatting 4
        - Text 4
        - Measurements 5
        - Axis numeric scales 5
    - Installation 5
    - The main window 5
    - My first plot 6
2. Reading data 9
    - Standard text import 9
        - Data types in text import 10
        - Descriptors 10
    - CSV files 11
    - HDF5 files 11
        - Error bars 12
        - Slices 12
        - 2D data ranges 12
        - Dates 12
    - 2D text or CSV format 12
    - FITS files 13
    - Reading other data formats 13
    - Manipulating datasets 14
        - Using dataset plugins 14
        - Using expressions to create new datasets 14
        - Linking datasets to expressions 15
        - Splitting data 15
        - Defining new constants or functions 15
        - Dataset plugins 16
    - Capturing data 16
3. Command line interface 17
    - Introduction 17
    - Commands 17
        - Action 17
        - Add 17
        - AddCustom 17
        - AddImportPath 18
        - CloneWidget 18
        - Close 18
        - CreateHistogram 18
        - DatasetPlugin 18
        - EnableToolbar 18
        - Export 19
        - FilterDatasets 19
        - ForceUpdate 19
        - Get 19
        - GetChildren 19
        - GetClick 19
        - GetData 20

GetDataType 20
GetDatasets 20
GPL 20
ImportFile 20
ImportFile2D 21
ImportFileCSV 21
ImportFileHDF5 22
ImportFilePlugin 22
ImportFITSFile 23
ImportString 23
ImportString2D 23
IsClosed 23
List 24
Load 24
MoveToPage 24
ReloadData 24
Rename 24
Remove 24
ResizeWindow 24
Save 25
Set 25
SetAntiAliasing 25
SetData 25
SetDataExpression 25
SetDataRange 25
SetData2D 26
SetData2DExpression 26
SetData2DExpressionXYZ 26
SetData2DXYFunc 26
SetDataDateTime 26
SetDataText 26
SetToReference 26
SetUpdateInterval 27
SetVerbose 27
StartSecondView 27
TagDatasets 27
To 27
Quit 27
WaitForClose 27
Zoom 28
Security 28
4. Using Veusz from other programs 29
Non-Qt Python programs 29
Older path-based interface 29
New-style object interface 30
Translating old to new style 33
PyQt4 programs 34
Non Python programs 34
C, C++ and Fortran 34

Chapter 1. Introduction

Veusz

Veusz is a scientific plotting package. It was designed to be easy to use, easily extensible, but powerful. The program features a graphical user interface, which works under Unix/Linux, Windows or Mac OS X. It can also be easily scripted (the saved file formats are similar to Python scripts) or used as module inside Python. Veusz reads data from a number of different types of data file, it can be manually entered, or constructed from other datasets.

In Veusz the document is built in an object-oriented fashion, where a document is built up by a number of widgets in a hierarchy. For example, multiple function or xy widgets can be placed inside a graph widget, and many graphs can be placed in a grid widget.

The technologies behind Veusz include PyQt (a very easy to use Python interface to Qt, which is used for rendering and the graphical user interface, GUI) and numpy (a package for Python which makes the handling of large datasets easy). Veusz can be extended by the user easily by adding plugins. Support for different data file types can be added with import plugins. Dataset plugins automate the manipulation of datasets. Tools plugins automate the manipulation of the document.

Terminology

Here we define some terminology for future use.

Widget

A document and its graphs are built up from widgets. These widgets can often by placed within each other, depending on the type of the widget. A widget has children (those widgets placed within it) and its parent. The widgets have a number of different settings which modify their behaviour. These settings are divided into properties, which affect what is plotted and how it is plotted. These would include the dataset being plotted or whether an axis is logarithmic. There are also formatting settings, including the font to be used and the line thickness. In addition they have actions, which perform some sort of activity on the widget or its children, like "fit" for a fit widget.

As an aside, using the scripting interface, widgets are specified with a "path", like a file in Unix or Windows. These can be relative to the current widget (do not start with a slash), or absolute (do not start with a slash). Examples of paths include, "/page1/graph1/x", "x" and ".".

The widget types include

1. **document** - representing a complete document. A document can contain pages. In addition it contains a setting giving the page size for the document.

2. **page** - representing a page in a document. One or more graphs can be placed on a page, or a grid.

3. **graph** - defining an actual graph. A graph can be placed on a page or within a grid. Contained within the graph are its axes and plotters. A graph can be given a background fill and a border if required. It also has a margin, which specifies how far away from the edge of its parent widget to plot the body of the graph.

   A graph can contain several axes, at any position on the plot. In addition a graph can use axes defined in parent widgets, shared with other graphs.

   More than one graph can be placed within in a page. The margins can be adjusted so that they lie within or besides each other.

4. **grid** - containing one or more graphs. A grid plots graphs in a gridlike fashion. You can specify the number of rows and columns, and the plots are automatically replotted in the chosen arrangement. A grid can contain graphs or axes. If an axis is placed in a grid, it can be shared by the graphs in the grid.

5. **axis** - giving the scale for plotting data. An axis translates the coordinates of the data to the screen. An axis can be linear or logarithmic, it can have fixed endpoints, or can automatically get them from the plotted data. It also has settings for the axis labels and lines, tick labels, and major and minor tick marks.

   An axis may be "horizontal" or "vertical" and can appear anywhere on its parent graph or grid.

   If an axis appears within a grid, then it can be shared by all the graphs which are contained within the grid.

   The **axis-broken** widget is an axis sub-type. It is an axis type where there are jumps in the scale of the axis.

   The **axis-function** widget allows the user to create an axis where the values are scaled by a monotonic function, allowing non-linear and non-logarithmic axis scales. The widget can also be linked to a different axis via the function.

6. plotters - types of widgets which plot data or add other things on a graph. There is no actual plotter widget which can be added, but several types of plotters listed below. Plotters typically take an axis as a setting, which is the axis used to plot the data on the graph (default x and y).

   a. **function** - a plotter which plots a function on the graph. Functions can be functions of x or y (parametric functions are not done yet!), and are defined in Python expression syntax, which is very close to most other languages. For example "3*x**2 + 2*x - 4". A number of functions are available (e.g. sin, cos, tan, exp, log...). Technically, Veusz imports the numpy package when evaluating, so numpy functions are available.

      As well as the function setting, also settable is the line type to plot the function, and the number of steps to evaluate the function when plotting. Filling is supported above/below/left/right of the function.

   b. **xy** - a plotter which plots scatter, line, or stepped plots. This versatile plotter takes an x and y dataset, and plots (optional) points, in a chosen marker and colour, connecting them with (optional) lines, and plotting (optional) error bars. An xy plotter can also plot a stepped line, allowing histograms to be plotted (note that it doesn't yet do the binning of the data).

      The settings for the xy widget are the various attibutes for the points, line and error bars, the datasets to plot, and the axes to plot on.

      The xy plotter can plot a label next to each dataset, which is either the same for each point or taken from a text dataset.

      If you wish to leave gaps in a plot, the input value "nan" can be specified in the numeric dataset.

   c. **fit** - fit a function to data. This plotter is a like the function plotter, but allows fitting of the function to data. This is achived by clicking on a "fit" button, or using the "fit" action of the widget. The fitter takes a function to fit containing the unknowns, e.g. "a*x**2 + b*x + c", and initial values for the variables (here a, b and c). It then fits the data (note that at the moment, the fit plotter fits all the data, not just the data that can be seen on the graph) by minimising the chi-squared.

      In order to fit properly, the y data (or x, if fitting as a function of x) must have a properly defined, preferably symmetric error. If there is none, Veusz assumes the same fractional error everywhere, or symmetrises asymmetric errors.

      Note that more work is required in this widget, as if a parameter is not well defined by the data, the matrix inversion in the fit will fail. In addition Veusz does not supply estimates for the errors or the final chi-squared in a machine readable way.

If the fitting parameters vary significantly from 1, then it is worth "normalizing" them by adding in a factor in the fit equation to bring them to of the order of 1.

d. **bar** - a bar chart which plots sets of data as horizontal or vertical bars. Multiple datasets are supported. In "grouped" mode the bars are placed side-by-side for each dataset. In "stacked" mode the bars are placed on top of each other (in the appropriate direction according to the sign of the dataset). Bars are placed on coordinates given, or in integer values from 1 upward if none are given. Error bars are plotted for each of the datasets.

   Different fill styles can be given for each dataset given. A separate key value can be given for each dataset.

e. **key** - a box which describes the data plotted. If a key is added to a plot, the key looks for "key" settings of the other data plotted within a graph. If there any it builds up a box containing the symbol and line for the plotter, and the text in the "key" setting of the widget. This allows a key to be very easily added to a plot.

   The key may be placed in any of the corners of the plot, in the centre, or manually placed. Depending on the ordering of the widgets, the key will be placed behind or on top of the widget. The key can be filled and surrounded by a box, or not filled or surrounded.

f. **label** - a text label places on a graph. The alignment can be adjusted and the font changed. The position of the label can be specified in fractional terms of the current graph, or using axis coordinates.

g. **rect, ellipse** - these draw a rectangle or ellipse, respectively, of size and rotation given. These widgets can be placed directly on the page or on a graph. The centre can be given in axis coordinates or fractional coordinates.

h. **imagefile** - draw an external graphs file on the graph or page, with size and rotation given. The centre can be given in axis coordinates or fractional coordinates.

i. **line** - draw a line with optional arrowheads on the graph or page. One end can be given in axis coordinates or fractional coordinates.

j. **contour** - plot contours of a 2D dataset on the graph. Contours are automatically calculated between the minimum and maximum values of the graph or chosen manually. The line style of the contours can be chosen individually and the region between contours can be filled with shading or color.

   2D datasets currently consist of a regular grid of values between minimum and maximum positions in x and y. They can be constructed from three 1D datasets of x, y and z if they form a regular x, y grid.

k. **image** - plot a 2D dataset as a colored image. Different color schemes can be chosen. The scaling between the values and the image can be specified as linear, logarithmic, square-root or square.

l. **polygon** - plot x and y points from datasets as a polygon. The polygon can be placed directly on the page or within a graph. Coordinates are either plotted using the axis or as fractions of the width and height of the containing widget.

m. **boxplot** - plot distribution of points in a dataset.

n. **polar** - plot polar data or functions. This is a non-orthogonal plot and is placed directly on the page rather than in a graph.

o. **ternary** - plot data of three variables which add up to 100 per cent.This is a non-orthogonal plot and is placed directly on the page rather than in a graph.

Settings: properties and formatting

The various settings of the widgets come in a number of types, including integers (e.g. 10), floats (e.g. 3.14), dataset names ("mydata"), expressions ("x+y"), text ("hi there!"), distances (see above), options ("horizontal" or "vertical" for axes).

Veusz performs type checks on these parameters. If they are in the wrong format the control to edit the setting will turn red. In the command line, a TypeError exception is thrown.

In the GUI, the current page is replotted if a setting is changed when enter is pressed or the user moves to another setting.

The settings are split up into formatting settings, controlling the appearance of the plot, or properties, controlling what is plotted and how it is plotted.

Default settings, including the default font and line style, and the default settings for any graph widget, can be modified in the "Default styles" dialog box under the "Edit" menu. Default settings are set on a per-document basis, but can be saved into a separate file and loaded. A default default settings file can be given to use for new documents (set in the preferences dialog).

Text

Veusz understands a limited set of LaTeX-like formatting for text. There are some differences (for example, "10^23" puts the 2 and 3 into superscript), but it is fairly similar. You should also leave out the dollar signs. Veusz supports superscripts ("^"), subscripts ("_"), brackets for grouping attributes are "{" and "}".

Supported LaTeX symbols include: \AA, \Alpha, \Beta, \Chi, \Delta, \Epsilon, \Eta, \Gamma, \Iota, \Kappa, \Lambda, \Mu, \Nu, \Omega, \Omicron, \Phi, \Pi, \Psi, \Rho, \Sigma, \Tau, \Theta, \Upsilon, \Xi, \Zeta, \alpha, \approx, \ast, \asymp, \beta, \bowtie, \bullet, \cap, \chi, \circ, \cup, \dagger, \dashv, \ddagger, \deg, \delta, \diamond, \divide, \doteq, \downarrow, \epsilon, \equiv, \eta, \gamma, \ge, \gg, \in, \infty, \int, \iota, \kappa, \lambda, \le, \leftarrow, \lhd, \ll, \models, \mp, \mu, \neq, \ni, \nu, \odot, \omega, \omicron, \ominus, \oplus, \oslash, \otimes, \parallel, \perp, \phi, \pi, \pm, \prec, \preceq, \propto, \psi, \rhd, \rho, \rightarrow, \sigma, \sim, \simeq, \sqrt, \sqsubset, \sqsubseteq, \sqsupset, \sqsupseteq, \star, \stigma, \subset, \subseteq, \succ, \succeq, \supset, \supseteq, \tau, \theta, \times, \umid, \unlhd, \unrhd, \uparrow, \uplus, \upsilon, \vdash, \vee, \wedge, \xi, \zeta. Please request additional characters if they are required (and exist in the unicode character set). Special symbols can be included directly from a character map.

Other LaTeX commands are supported. "\\" breaks a line. This can be used for simple tables. For example "{a\\b} {c \\d}" shows "a c" over "b d". The command "\frac{a}{b}" shows a vertical fraction a/b.

Also supported are commands to change font. The command "\font{name}{text}" changes the font text is written in to name. This may be useful if a symbol is missing from the current font, e.g. "\font{symbol}{g}" should produce a gamma. You can increase, decrease, or set the size of the font with "\size{+2}{text}", "\size{-2}{text}", or "\size{20}{text}". Numbers are in points.

Various font attributes can be changed: for example, "\italic{some italic text}" (or use "\textit" or "\emph"), "\bold{some bold text}" (or use "\textbf") and "\underline{some underlined text}".

Example text could include "Area / \pi (10^{-23} cm^{-2})", or "\pi\bold{g}".

Veusz plots these symbols with Qt's unicode support. You can also include special characters directly, by copying and pasting from a character map application. If your current font does not contain these symbols then you may get a box character.

Measurements

Distances, widths and lengths in Veusz can be specified in a number of different ways. These include absolute distances specified in physical units, e.g. 1cm, 0.05m, 10mm, 5in and 10pt, and relative units, which are relative to the largest dimension of the page, including 5%, 1/20, 0.05.

Axis numeric scales

The way in which numbers are formatted in axis scales is chosen automatically. For standard numerical axes, values are shown with the "%Vg" formatting (see below). For date axes, an appropriate date formatting is used so that the interval shown is correct. A format can be given for an axis in the axis number formatting panel can be given to explicitly choose a format. Some examples are given in the drop down axis menu. Hold the mouse over the example for detail.

C-style number formatting is used with a few Veusz specific extensions. Text can be mixed with format specifiers, which start with a "%" sign. Examples of C-style formatting include: "%.2f" (decimal number with two decimal places, e.g. 2.01), "%.3e" (scientific formatting with three decimal places, e.g. 2.123e-02), "%g" (general formatting, switching between "%f" and "%e" as appropriate). See http://opengroup.org/onlinepubs/007908799/xsh/fprintf.html for details.

Veusz extensions include "%Ve", which is like "%e" except it displays scientific notation as written, e.g. 1.2x10^23, rather than 1.2e+23. "%Vg" switches between standard numbers and Veusz scientific notation for large and small numbers. "%VE" using engineering SI suffixes to represent large or small numbers (e.g. 1000 is 1k).

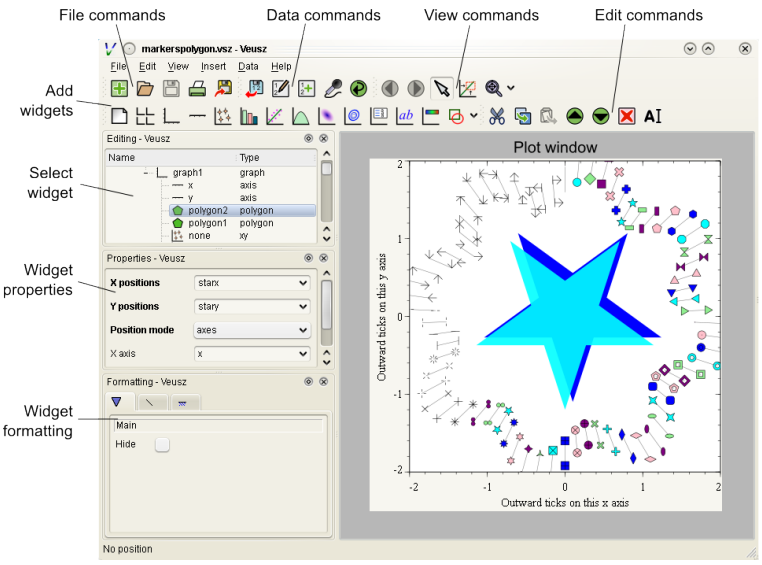
Veusz allows dates and times to be formatted using "%VDX" where "X" is one of the formatting characters for strftime (see http://opengroup.org/onlinepubs/007908799/xsh/strftime.html for details). These include "a" for an abbreviated weekday name, "A" for full weekday name, "b" for abbreviated month name, "B" for full month name, "c" date and time representaiton, "d" day of month 01..31, "H" hour as 00..23, "I" hour as 01..12, "j" as day of year 001..366, "m" as month 01..12, "M" minute as 00..59, "p" AM/PM, "S" second 00..61, "U" week number of year 00..53 (Sunday as first day of week), "w" weekday as decimal number 0..6, "W" week number of year (Monday as first day of week), "x" date representation, "X" time representation, "y" year without century 00..99 and "Y" year. "%VDVS" is a special Veusz addon format which shows seconds and fractions of seconds (e.g. 12.2).

Installation

Please look at the Installation notes (INSTALL) for details on installing Veusz.

The main window

You should see the main window when you run Veusz (you can just type the veusz command in Unix).



The Veusz window is split into several sections. At the top is the menu bar and tool bar. These work in the usual way to other applications. Sometimes options are disabled (greyed out) if they do not make sense to be used. If you hold your mouse over a button for a few seconds, you will usually get an explanation for what it does called a "tool tip".

Below the main toolbar is a second toolbar for constructing the graph by adding widgets (on the left), and some editing buttons. The add widget buttons add the request widget to the currently selected widget in the selection window. The widgets are arranged in a tree-like structure.

Below these toolbars and to the right is the plot window. This is where the current page of the current document is shown. You can adjust the size of the plot on the screen (the zoom factor) using the "View" menu or the zoom tool bar button (the magnifying glass). Initially you will not see a plot in the plot window, but you will see the Veusz logo. At the moment you cannot do much else with the window. In the future you will be able to click on items in the plot to modify them.

To the left of the plot window is the selection window, and the properties and formatting windows. The properties window lets you edit various aspects of the selected widget (such as the minimum and maximum values on an axis). Changing these values should update the plot. The formatting lets you modify the appearance of the selected widget. There are a series of tabs for choosing what aspect to modify.

The various windows can be "dragged" from the main window to "float" by themselves on the screen.

To the bottom of the window is the console. This window is not shown by default, but can be enabled in the View menu. The console is a Veusz and Python command line console. To read about the commands available see Commands. As this is a Python console, you can enter mathematical expressions (e.g. "1+2.0*cos(pi/4)") here and they will be evaluated when you press Enter. The usual special functions and the operators are supported. You can also assign results to variables (e.g. "a=1+2") for use later. The console also supports command history like many Unix shells. Press the up and down cursor keys to browse through the history. Command line completion is not available yet!

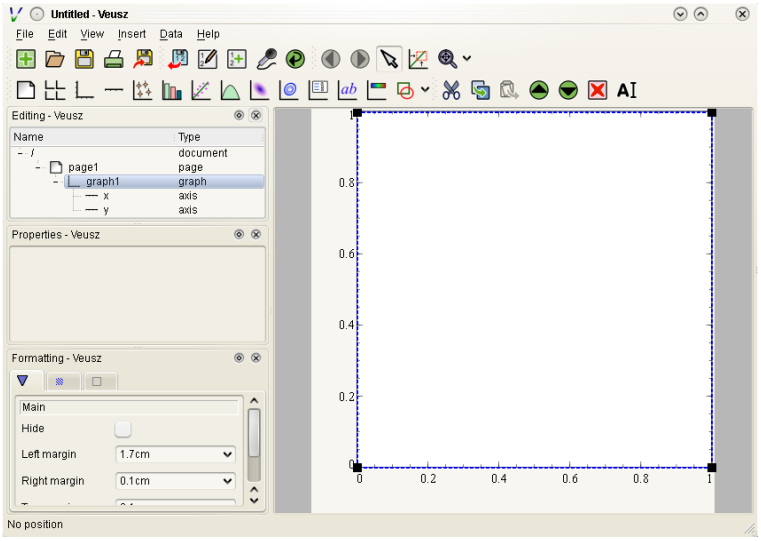
There also exists a dataset browsing window, by default to the right of the screen. This window allows you to view the datasets currently loaded, their dimensions and type. Hovering a mouse over the size of the dataset will give you a preview of the data.

My first plot

After opening Veusz, on the left of the main window, you will see a Document, containing a Page, which contains a Graph with its axes. The Graph is selected in the selection window. The toolbar above adds a new widget to the

selected widget. If a widget cannot be added to a selected widget it is disabled. On opening a new document Veusz automatically adds a new Page and Graph (with axes) to the document.

You will see something like this:



Select the x axis which has been added to the document (click on "x" in the selection window). In the properties window you will see a variety of different properties you can modify. For instance you can enter a label for the axis by writing "Area (cm^{2})" in the box next to label and pressing enter. Veusz supports text in LaTeX-like form (without the dollar signs). Other important parameters is the "log" switch which switches between linear and logarithmic axes, and "min" and "max" which allow the user to specify the minimum and maximum values on the axes.

The formatting dialog lets you edit various aspects of the graph appearance. For instance the "Line" tab allows you to edit the line of the axis. Click on "Line", then you can then modify its colour. Enter "green" instead of "black" and press enter. Try making the axis label bold.

Now you can try plotting a function on the graph. If the graph, or its children are selected, you will then be able to click the "function" button at the top (a red curve on a graph). You will see a straight line (y=x) added to the plot. If you select "function1", you will be able to edit the functional form plotted and the style of its line. Change the function to "x**2" (x-squared).

We will now try plotting data on the graph. Go to your favourite text editor and save the following data as test.dat:

```
1     0.1   -0.12   1.1    0.1
2.05  0.12  -0.14   4.08   0.12
2.98  0.08  -0.1    2.9    0.11
4.02  0.04  -0.1    15.3   1.0
```

The first three columns are the x data to plot plus its asymmetric errors. The final two columns are the y data plus its symmetric errors. In Veusz, go to the "Data" menu and select "Import". Type the filename into the filename box, or use the "Browse..." button to search for the file. You will see a preview of the data pop up in the box below. Enter "x,+,- y,+-" into the descriptors edit box (note that commas and spaces in the descriptor are almost interchangeable in Veusz 1.6 or newer). This describes the format of the data which describes dataset "x" plus its asymmetric errors, and "y" with its symmetric errors. If you now click "Import", you will see it has imported datasets "x" and "y".

To plot the data you should now click on "graph1" in the tree window. You are now able to click on the "xy" button (which looks like points plotted on a graph). You will see your data plotted on the graph. Veusz plots datasets "x" and "y" by default, but you can change these in the properties of the "xy" plotter.

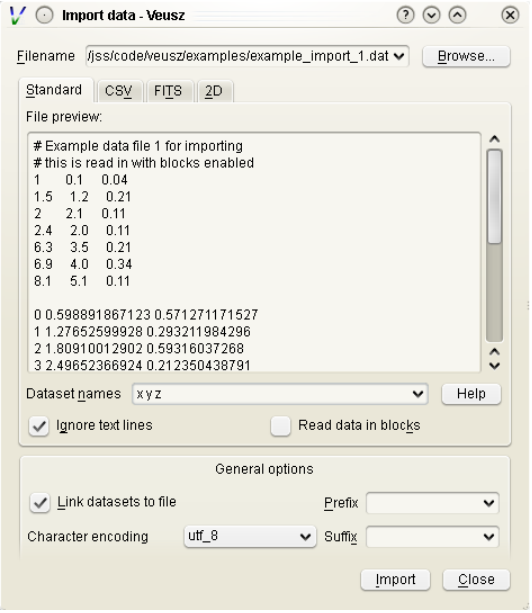
You are able to choose from a variety of markers to plot. You can remove the plot line by choosing the "Plot Line" subsetting, and clicking on the "hide" option. You can change the colour of the marker by going to the "Marker Fill" subsetting, and entering a new colour (e.g. red), into the colour property.

Chapter 2. Reading data

Currently Veusz supports reading data from files with text, CSV, HDF5, FITS, 2D text or CSV, QDP, binary and NPY/NPZ formats. Use the Data → Import dialog to read data, or the importing commands in the API can be used. In addition, the user can load or write import plugins in Python which load data into Veusz in an arbitrary format. At the moment QDP, binary and NPY/NPZ files are supported with this method. The HDF5 file format is the most sophisticated, and is recommended for complex datasets.

By default, data are "linked" to the file imported from. This means that the data are not stored in the Veusz saved file and are reloaded from the original data file when opening. In addition, the user can use the Data → Reload menu option to reload data from linked files. Unselect the linked option when importing to remove the association with the data file and to store the data in the Veusz saved document.

Note that a prefix and suffix can be given when importing. These are added to the front or back of each dataset name imported. They are convenient for grouping data together.



We list the various types of import below.

Standard text import

The default text import operates on simple text files. The data are assumed to be in columns separated by whitespace. Each column corresponds to dataset (or its error bars). Each row is an entry in the dataset.

The way the data are read is goverened by a simple "descriptor". This can simply be a list of dataset names separated by spaces. If no descriptor is given, the columns are treated as separate datasets and are given names col1, col2, etc. Veusz attempts to automatically determine the type of the data.

When reading in data, Veusz treats any whitespace as separating columns. The columns do not actually need to be aligned. Furthermore a "\" symbol can be placed at the end of a line to mark a continuation. Veusz will read the next line as if it were placed at the end of the current line. In addition comments and blank lines are ignored (unless in block mode). Comments start with a "#", ";", "!" or "%", and continue until the end of the line. The special value "nan" can be used to specify a break in a dataset.

If the option to read data in blocks is enabled, Veusz treats blank lines (or lines starting with the word "no") as block separators. For each dataset in the descriptor, separate datasets are created for each block, using a numeric suffix giving the block number, e.g. _1, _2.

Data types in text import

Veusz supports reading in several types of data. The type of data can be added in round brackets after the name in the descriptor. Veusz will try to guess the type of data based on the first value, so you should specify it if there is any form of ambiguity (e.g. is 3 text or a number). Supported types are numbers (use numeric in brackets) and text (use text in brackets). An example descriptor would be "x(numeric) +- y(numeric) + - label(text)" for an x dataset followed by its symmetric errors, a y dataset followed by two columns of asymmetric errors, and a final column of text for the label dataset.

A text column does not need quotation unless it contains space characters or escape characters. However make sure you deselect the "ignore text" option in the import dialog. This ignores lines of text to ease the import of data from other applications. Quotation marks are recommended around text if you wish to avoid ambiguity. Text is quoted according to the Python rules for text. Double or single quotation marks can be used, e.g. "A 'test'", 'A second "test"'. Quotes can be escaped by prefixing them with a backslash, e.g. "A new \"test\"". If the data are generated from a Python script, the repr function provides the text in a suitable form.

Dates and times are also supported with the syntax "dataset(date)". Dates must be in ISO format YYYY-MM-DD. Times are in 24 hour format hh:mm:ss.ss. Dates with times are written YYYY-MM-DDThh:mm:ss.ss (this is a standard ISO format, see http://www.w3.org/TR/NOTE-datetime). Dates are stored within Veusz as a number which is the number of seconds since the start of January 1st 2009. Veusz also supports dates and times in the local format, though take note that the same file and data may not work on a system in a different location.

Descriptors

A list of datasets, or a "Descriptor", is given in the Import dialog to describe how the data are formatted in the import file. The descriptor at its simplest is a space or comma-separated list of the names of the datasets to import. These are columns in the file.

Following a dataset name the text "+", "-", or "+-" can be given to say that the following column is a positive error bar, negative error bar or symmetric error bar for the previous (non error bar) dataset. These symbols should be separated from the dataset name or previous symbol with a space or a comma symbol.

In addition, if multiple numbered columns should be imported, the dataset name can be followed by square brackets containing a range in the form "[a:b]" to number columns a to b, or [:] to number remaining columns. See below for examples of this use.

Dataset names can contain virtually any character, even unicode characters. If the name contains non alpha-numeric characters (characters outside of A-Z, a-z and 0-9), then the dataset name should be contained within back-tick characters. An example descriptor is **`length data (m)`,+- `speed (mps)`,+,-**, for two datasets with spaces and brackets in their names.

Instead of specifying the descriptor in the Import dialog, the descriptor can be placed in the data file using a descriptor statement on a separate line, consisting of "descriptor" followed by the descriptor. Multiple descriptors can be placed in a single file, for example:

```
# here is one section
descriptor x,+- y,+,-
1 0.5  2 0.1 -0.1
2 0.3  4 0.2 -0.1

# my next block
```

```
descriptor alpha beta gamma
1 2 3
4 5 6
7 8 9

# etc...
```

Descriptor examples

1. **x y** two columns are present in the file, they will be read in as datasets "x" and "y".

2. **x,+- y,+,-** or **x +- y + -** two datasets are in the file. Dataset "x" consists of the first two columns. The first column are the values and the second are the symmetric errors. "y" consists of three columns (note the comma between + and -). The first column are the values, the second positive asymmetric errors, and the third negative asymmetric errors.

   Suppose the input file contains:

   ```
   1.0  0.3  2   0.1  -0.2
   1.5  0.2  2.3 2e-2 -0.3E0
   2.19 0.02 5    0.1 -0.1
   ```

   Then x will contain "1+-0.3", "1.5+-0.2", "2.19+-0.02". y will contain "2 +0.1 -0.2", "2.3 +0.02 -0.3", "5 +0.1 -0.1".

3. **x[1:2] y[:]** the first column is the data "x_1", the second "x_2". Subsequent columns are read as "y[1]" to "y[n]".

4. **y[:]+-** read each pair of columns as a dataset and its symmetric error, calling them "y[1]" to "y[n]".

5. **foo,,+-** read the first column as the foo dataset, skip a column, and read the third column as its symmetric error.

CSV files

CVS (comma separated variable) files are often written from other programs, such as spreadsheets, including Excel and Gnumeric. Veusz supports reading from these files.

In the import dialog choose "CSV", then choose a filename to import from. In the CSV file the user should place the data in either rows or columns. Veusz will use a name above a column or to the left of a row to specify what the dataset name should be. The user can use new names further down in columns or right in rows to specify a different dataset name. Names do not have to be used, and Veusz will assign default "col" and "row" names if not given. You can also specify a prefix which is prepended to each dataset name read from the file.

To specify symmetric errors for a column, put "+-" as the dataset name in the next column or row. Asymmetric errors can be stated with "+" and "-" in the columns.

The data type in CSV files are automatically detected unless specified. The data type can be given in brackets after the column name, e.g. "name (text)", where the data type is "date", "numeric" or "text". Explicit data types are needed if the data look like a different data type (e.g. a text item of "1.23"). The date format in CSV files can be specified in the import dialog box - see the examples given. In addition CSV files support numbers in European format (e.g. 2,34 rather than 2.34), depending on the setting in the dialog box.

HDF5 files

HDF5 is a flexible data format. Datasets and tables can be stored in a hierarchical arrangements of groups within a file. Veusz supports reading 1D numeric, text, date-time or 2D numeric data from HDF files. The **h5py** Python module must be installed to use HDF5 files (included in binary releases).

In the import dialog box, choose which individual datasets to import, or selecting a group to import all the datasets within the group. If selecting a group, datasets in the group incompatible with Veusz are ignored.

A name can be provided for each dataset imported by entering one under "Import as". If one is not given, the dataset or column name is used. The name can also be specified by setting the HDF5 dataset attribute `vsz_name` to the name. Note that for compound datasets (tables), `vsz_` attributes for columns are given by appending the suffix `_column-name` to the attribute.

Error bars

Error bars are supported in two ways. The first way is to combine 1D datasets. For the datasets which are error bars, use a name which is the same as the main dataset but with the suffix "(+-)", "(+)" or "(-)", for symmetric, postive or negative error bars, respectively. The second method is to use a 2D dataset with two or three columns, for symmetric or asymmetric error bars, respectively. Click on the dataset in the dialog and choose the option to import as a 1D dataset. This second method can also be enabled by adding an HDF5 attribute `vsz_twod_as_oned` set to a non-zero value for the dataset.

Slices

As Veusz only supports 1D and 2D datasets, you may wish to reduce the dimensions of a dataset before importing by slicing. You can also give a slice to import a subset of a dataset. When importing, in the slice column you can give a slice expression. This should have the same number of entries as the dataset has dimensions, separated by commas. An entry can be a single number, to select a particular row or column. Alternatively it could be an expression like `a:b:c` or `a:b`, where `a` is the starting index, `b` is one beyond the stopping index and optionally `c` is the step size. A slice can also be specified by providing an HDF5 attribute `vsz_slice` for the dataset.

2D data ranges

2D data have an associated X and Y range. By default the number of pixels of the image are used to give this range. A range can be specified by clicking on the dataset and entering a minimum and maximum X and Y coordinates. Alternatively, provide the HDF5 attribute for the dataset `vsz_range`, which should be set to an array of four values (minimum x, minimum y, maximum x, maximum y).

Dates

Date/time datasets can be made from a 1D numeric dataset or from a text dataset. For the 1D dataset, use the number of seconds relative to the start of the year 2009 (this is Veusz format) or the year 1970 (this is Unix format). In the import dialog, click on the name of the dataset and choose the date option. To specify a date format in the HDF5 file, set the attribute `vsz_convert_datetime` to either `veusz` or `unix`.

For text datasets, dates must be given in the right format, selected in the import dialog after clicking on the dataset name. As in other file formats, by default Veusz uses ISO 8601 format, which looks like "2013-12-22T21:08:07", where the date and time parts are optional. The T is also optional. You can also provide your own format when importing by giving a date expression using YYYY, MM, DD, hh, mm and ss (e.g. "YYYY-MM-DD|T|hh:mm:ss"), where vertical bars mark optional parts of the expression. To automate this, set the attribute `vsz_convert_datetime` to the format expression or `iso` to specify ISO format.

2D text or CSV format

Veusz can import 2D data from standard text or CSV files. In this case the data should consist of a matrix of data values, with the columns separated by one or more spaces or tabs and the rows on different lines.

In addition to the data the file can contain lines at the top which affect the import. Such specifiers are used, for example, to change the coordinates of the pixels in the file. By default the first pixels coordinates is between 0 and 1, with the centre at 0.5. Subsequent pixels are 1 greater. Note that the lowest coordinate pixel is the bottom-left value in the table of imported values. When using specifiers in CSV files, put the different parts (separated by spaces) in separate columns. Below are listed the specifiers:

1. **xrange A B** - make the 2D dataset span the coordinate range A to B in the x-axis (where A and B are numbers). Note that the range is inclusive, so a 1 pixel wide image with A=0 and B=1 would have the pixel centre at 0.5. The pixels are assumed to have the same spacing. Do not use this as the same time as the **xedge** or **xcent** options.

2. **yrange A B** - make the 2D dataset span the coordinate range A to B in the y-axis (where A and B are numbers).

3. **xedge A B C...** - rather than assume the pixels have the same spacing, give the coordinates of the edges of the pixels in the x-axis. The numbers should be space-separated and there should be one more number than pixels. Do not give **xrange** or **xcent** if this is given. If the values are increasing, the lowest coordinate value is at the left of the dataset, otherwise if they are decreasing, it is on the right (unless the rows/columns are inverted or transposed).

4. **yedge A B C...** - rather than assume the pixels have the same spacing, give the coordinates of the edges of the pixels in the y-axis. If the values are increasing, the lowest coordinate value is at the bottom row. If they instead decrease, it is at the top.

5. **xcent A B C...** - rather than give a total range or pixel edges, give the centres of the pixels. There should be the same number of values as pixels in the image. Do not give **xrange** or **xedge** if this is given. The order of the values specify whether the pixels are left to right or right to left.

6. **ycent A B C...** - rather than give a total range or pixel edges, give the centres of the pixels. The value order specifies whether the pixels are bottom to top, or top to bottom.

7. **invertrows** - invert the rows after reading the data.

8. **invertcols** - invert the columns after reading the data.

9. **transpose** - swap rows and columns after importing data.

10. **gridatedge** - the first row and leftmost column give the positions of the centres of the pixels. This is also an option in the import dialog. The values should be increasing or decreasing.

FITS files

1D or 2D data can be read from FITS files. 1D data, with optional errors bars, can be read from table extensions, and 2D data from image or primary extensions. Note that pyfits or astropy must be installed to get FITS support.

To read 1D data, choose a tabular HDU for to import from, enter the name to give the imported data, and choose the columns to assign to the data. Multiple sets of data can be read by repeatedly importing.

For 2D data, choose an image HDU. Enter the name of the dataset. The data are imported with pixel coordinates by default (i.e. the pixels are numbered with integers). Other modes can be selected under Image WCS mode. These include fractional, where the pixels are numbered between 0 and 1. Pixel (WCS) assigns the pixel coordinate calculated relative to the `CRPIX1/2` header keywords. Linear (WCS) uses linear coordinates where the Pixel (WCS) coordinates are multiplied by the respective `CDELT1/2` values and added to the `CRVAL1/2` values.

Reading other data formats

As mentioned above, a user may write some Python code to read a data file or set of data files. To write a plugin which is incorportated into Veusz, see http://barmag.net/veusz-wiki/ImportPlugins

You can also include Python code in an input file to read data, which we describe here. Suppose an input file "in.dat" contains the following data:

```
1   2
2   4
3   9
4   16
```

Of course this data could be read using the ImportFile command. However, you could also read it with the following Veusz script (which could be saved to a file and loaded with **execfile** or Load. The script also places symmetric errors of 0.1 on the x dataset.

```
x = []
y = []
for line in open("in.dat"):
    parts = [float(i) for i in line.split()]
    x.append(parts[0])
    y.append(parts[1])

SetData('x', x, symerr=0.1)
SetData('y', y)
```

Manipulating datasets

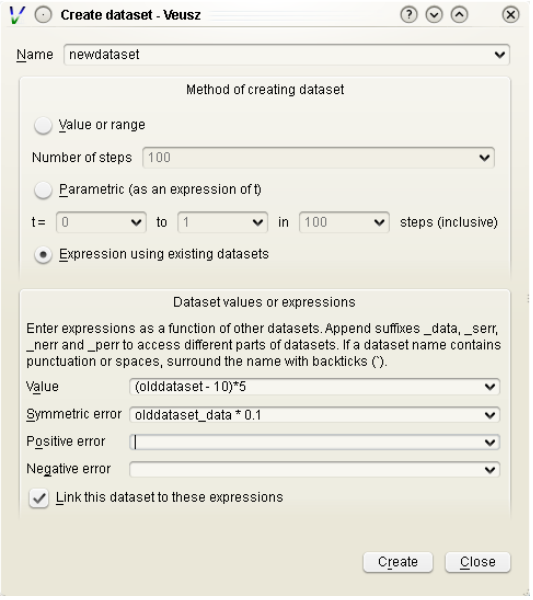
Imported datasets can easily be modified in the Data Editor dialog box. This dialog box can also be used to create new datasets from scratch by typing them in. The Data Create dialog box is used to new datasets as a numerical sequence, parametrically or based on other datasets given expressions. If you want to plot a function of a dataset, you often do not have to create a new dataset. Veusz allows to enter expressions directly in many places.

Using dataset plugins

Dataset plugins can be used to perform arbitrary manipulation of datasets. Veusz includes several plugins for mathematical operation of data and other dataset manipulations, such as concatenation or splitting. If you wish to write your own plugins look at http://barmag.net/veusz-wiki/DatasetPlugins.

Using expressions to create new datasets

For instance, if the user has already imported dataset d, then they can create d2 which consists of d**2. Expressions are in Python numpy syntax and can include the usual mathematical functions.



Expressions for error bars can also be given. By appending **_data**, **_serr**, **_perr** or **_nerr** to the name of the dataset in the expression, the user can base their expression on particular parts of the given dataset (the main data, symmetric errors, positive errors or negative errors). Otherwise the program uses the same parts as is currently being specified.

If a dataset name contains non alphanumeric characters, its name should be quoted in the expression in back-tick characters, e.g. **`length (cm)`*2**.

The numpy functionality is particularly useful for doing more complicated expressions. For instance, a conditional expression can be written as **where(x<y,x,y)** or **where(isfinite(x),a,b))**.

You often do not need to create a new dataset when. For example, with the xy point plotter widget, you can directly enter an expression as the X and Y dataset settings. When you give a direct dataset expression, you can define error bar expressions by separating them by commas, and optionally surrounding them by brackets. For example **(a,0.1)** plots dataset a as the data, with symmetric errors bars of 0.1. Asymmetric bars are given as **(a,a*0.1,-a*0.1)**.

Linking datasets to expressions

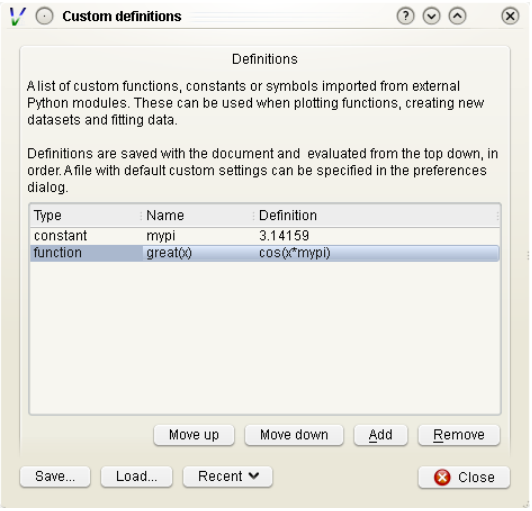
A particularly useful feature is to be able to link a dataset to an expression, so if the expression changes the dataset changes with it, like in a spreadsheet.

Splitting data

Data can also be chopped in this method, for example using the expression **x[10:20]**, which makes a dataset based on the 11th to 20th item in the x dataset (the ranges are Python syntax, and are zero-based). Negative indices count backwards from the end of the dataset. Data can be skipped using expressions such as **data[::2]**, which skips every other element

Defining new constants or functions

User defined constants or functions can be defined in the "Custom definitions" dialog box under the edit menu. Functions can also be imported from external python modules.



Custom definitions are defined on a per-document basis, but can be saved or loaded into a file. A default custom definitions file can be set in the preferences dialog box.

Dataset plugins

In addition to creating datasets based on expressions, a variety of dataset plugins exist, which make certain operations on datasets much more convenient. See the Data, Operations menu for a list of the default plugins. The user can easily create new plugins. See http://barmag.net/veusz-wiki/DatasetPlugins for details.

Capturing data

In addition to the standard data import, data can be captured as it is created from an external program, a network socket or a file or named pipe. When capturing from a file, the behaviour is like the Unix **tail -f** command, where new lines written to the file are captured. To use the capturing facility, the data must be written in the simple line based standard Veusz text format. Data are whitespace separated, with one value per dataset given on a single line.

To capture data, use the dialog box Data $\rightarrow$ Capture. A list of datasets should be given. This is the standard descriptor format. Choose the source of the data, which is either a a filename or named pipe, a network socket to connect to, or a command line for an external program. Capturing ends if the source of the data runs out (for external programs or network sockets) or the finish button is clicked. It can optionally end after a certain number of data lines or when a time period has expired. Normally the data are updated in Veusz when the capturing is finished. There is an option to update the document at intervals, which is useful for monitoring. A plot using the variables will update when the data are updated.

Click the `Capture` button to start the capture. Click `Finish` or `Cancel` to stop. Cancelling destroys captured data.

Chapter 3. Command line interface

Introduction

An alternative way to control Veusz is via its command line interface. As Veusz is a a Python application it uses Python as its scripting language. Therefore you can freely mix Veusz and Python commands on the command line. Veusz can also read in Python scripts from files (see the Load command).

When commands are entered in the command prompt in the Veusz window, Veusz supports a simplified command syntax, where brackets following commands names, and commas, can replaced by spaces in Veusz commands (not Python commands). For example, **Add('graph', name='foo')**, may be entered as **Add 'graph' name='foo'**.

The **numpy** package is already imported into the command line interface (as "*"), so you do not need to import it first.

The command prompt supports history (use the up and down cursor keys to recall previous commands).

Most of the commands listed below can be used in the in-program command line interface, using the embedding interface or using veusz_listen. Commands specific to particular modes are documented as such.

Veusz also includes a new object-oriented version of the interface, which is documented at http://barmag.net/veusz-wiki/EmbeddingPython.

Commands

We list the allowed set of commands below

Action

Action('actionname', componentpath='.')

Initiates the specified action on the widget (component) given the action name. Actions perform certain automated routines. These include "fit" on a fit widget, and "zeroMargins" on grids.

Add

Add('widgettype', name='nameforwidget', autoadd=True, optionalargs)

The Add command adds a graph into the current widget (See the To command to change the current position).

The first argument is the type of widget to add. These include "graph", "page", "axis", "xy" and "grid". **name** is the name of the new widget (if not given, it will be generated from the type of the widget plus a number). The **autoadd** parameter if set, constructs the default sub-widgets this widget has (for example, axes in a graph).

Optionally, default values for the graph settings may be given, for example **Add('axis', name='y', direction='vertical')**.

Subsettings may be set by using double underscores, for example **Add('xy', MarkerFill__color='red', ErrorBarLine__hide=True)**.

Returns: Name of widget added.

AddCustom

AddCustom(type, name, value)

Add a custom definition for evaluation of expressions. This can define a constant (can be in terms of other constants), a function of 1 or more variables, or a function imported from an external python module.

ctype is "constant", "function" or "import".

name is name of constant, or "function(x, y, ...)" or module name.

val is definition for constant or function (both are _strings_), or is a list of symbols for a module (comma separated items in a string).

If mode is 'appendalways', the custom value is appended to the end of the list even if there is one with the same name. If mode is 'replace', it replaces any existing definition in the same place in the list or is appended otherwise. If mode is 'append', then an existing definition is deleted, and the new one appended to the end.

AddImportPath

AddImportPath(directory)

Add a directory to the list of directories to try to import data from.

CloneWidget

CloneWidget(widget, newparent, newname=None)

Clone the widget given, placing the copy in newparent and the name given. newname is an optional new name to give it Returns new widget path.

Close

Close()

Closes the plotwindow. This is only supported in embedded mode.

CreateHistogram

CreateHistogram(inexpr, outbinsds, outvalsds, binparams=None, binmanual=None, method='counts', cumulative = 'none', errors=False)

Histogram an input expression. inexpr is input expression. outbinds is the name of the dataset to create giving bin positions. outvalsds is name of dataset for bin values. binparams is None or (numbins, minval, maxval, islogbins). binmanual is None or a list of bin values. method is 'counts', 'density', or 'fractions'. cumulative is to calculate cumulative distributions which is 'none', 'smalltolarge' or 'largetosmall'. errors is to calculate Poisson error bars.

DatasetPlugin

DatasetPlugin(pluginname, fields, datasetnames={})>

Use a dataset plugin. pluginname: name of plugin to use fields: dict of input values to plugin datasetnames: dict mapping old names to new names of datasets if they are renamed. The new name None means dataset is deleted

EnableToolbar

EnableToolbar(enable=True)

Enable/disable the zooming toolbar in the plotwindow. This command is only supported in embedded mode or from veusz_listen.

Export

Export(filename, color=True, page=0 dpi=100, antialias=True, quality=85, backcolor='#ffffff00', pdfdpi=150, svgtextastext=False)

Export the page given to the filename given. The **filename** must end with the correct extension to get the right sort of output file. Currrenly supported extensions are '.eps', '.pdf', '.ps', '.svg', '.jpg', '.jpeg', '.bmp' and '.png'. If **color** is True, then the output is in colour, else greyscale. **page** is the page number of the document to export (starting from 0 for the first page!). A list of pages can be given for multipage formats (.pdf or .ps). **dpi** is the number of dots per inch for bitmap output files. **antialias** - antialiases output if True. **quality** is a quality parameter for jpeg output. **backcolor** is the background color for bitmap files, which is a name or a #RRGGBBAA value (red, green, blue, alpha). **pdfdpi** is the dpi to use when exporting EPS or PDF files. **svgtextastext** says whether to export SVG text as text, rather than curves.

FilterDatasets

FilterDatasets(filterexpr, datasets, prefix="", suffix="", invert=False, replaceblanks=False)

Filter a list of datasets given. Creates new datasets for each with prefix and suffix added to input dataset names. filterexpr is an input numpy eexpression for filtering the datasets. If invert is set, the filter condition is inverted. If replaceblanks is set, filtered values are not removed, but replaced with a blank or NaN value. This command only works on 1D numeric, date or text datasets.

ForceUpdate

ForceUpdate()

Force the window to be updated to reflect the current state of the document. Often used when periodic updates have been disabled (see SetUpdateInterval). This command is only supported in embedded mode or from veusz_listen.

Get

Get('settingpath')

Returns: The value of the setting given by the path.

```
>>> Get('/page1/graph1/x/min')
'Auto'
```

GetChildren

GetChildren(where='.')

Returns: The names of the widgets which are children of the path given

GetClick

GetClick()

Waits for the user to click on a graph and returns the position of the click on appropriate axes. Command only works in embedded mode.

Returns: A list containing tuples of the form (axispath, val) for each axis for which the click was in range. The value is the value on the axis for the click.

GetData

GetData(name)

Returns: For a 1D dataset, a tuple containing the dataset with the name given. The value is (data, symerr, negerr, poserr), with each a numpy array of the same size or None. data are the values of the dataset, symerr are the symmetric errors (if set), negerr and poserr and negative and positive asymmetric errors (if set). If a text dataset, return a list of text elements. If the dataset is a date-time dataset, return a list of Python datetime objects. If the dataset is a 2D dataset return the tuple (data, rangex, rangey), where data is a 2D numpy array and rangex/y are tuples giving the range of the x and y coordinates of the data.

```
data = GetData('x')
SetData('x', data[0]*0.1, *data[1:])
```

GetDataType

GetDataType(name)

Get type of dataset with name given. Returns '1d' for a 1d dataset, '2d' for a 2d dataset, 'text' for a text dataset and 'datetime' for a datetime dataset.

GetDatasets

GetDatasets()

Returns: The names of the datasets in the current document.

GPL

GPL()

Print out the GNU Public Licence, which Veusz is licenced under.

ImportFile

ImportFile('filename', 'descriptor', linked=False, prefix='', suffix='', encoding='utf_8', renames={})

Imports data from a file. The arguments are the filename to load data from and the descriptor.

The format of the descriptor is a list of variable names representing the columns of the data. For more information see Descriptors.

If the linked parameter is set to True, if the document is saved, the data imported will not be saved with the document, but will be reread from the filename given the next time the document is opened. The linked parameter is optional.

If prefix and/or suffix are set, then the prefix and suffix are added to each dataset name. If set, renames maps imported dataset names to final dataset names after import.

Returns: A tuple containing a list of the imported datasets and the number of conversions which failed for a dataset.

Changed in version 0.5: A tuple is returned rather than just the number of imported variables.

ImportFile2D

ImportFile2D('filename', datasets, xrange=(a,b), yrange=(c,d), invertrows=True/False, invertcols=True/False, transpose=True/False, prefix='', suffix='', linked=False, encoding='utf8', renames={})

Imports two-dimensional data from a file. The required arguments are the filename to load data from and the dataset name, or a list of names to use.

filename is a string which contains the filename to use. datasets is either a string (for a single dataset), or a list of strings (for multiple datasets).

The xrange parameter is a tuple which contains the range of the X-axis along the two-dimensional dataset, for example (-1., 1.) represents an inclusive range of -1 to 1. The yrange parameter specifies the range of the Y-axis similarly. If they are not specified, (0, N) is the default, where N is the number of datapoints along a particular axis.

invertrows and invertcols if set to True, invert the rows and columns respectively after they are read by Veusz. transpose swaps the rows and columns.

If prefix and/or suffix are set, they are prepended or appended to imported dataset names. If set, renames maps imported dataset names to final dataset names after import.

If the linked parameter is True, then the datasets are linked to the imported file, and are not saved within a saved document.

The file format this command accepts is a two-dimensional matrix of numbers, with the columns separated by spaces or tabs, and the rows separated by new lines. The X-coordinate is taken to be in the direction of the columns. Comments are supported (use "#", "!" or "%"), as are continuation characters ("\"). Separate datasets are deliminated by using blank lines.

In addition to the matrix of numbers, the various optional parameters this command takes can also be specified in the data file. These commands should be given on separate lines before the matrix of numbers. They are:

1. xrange A B
2. yrange C D
3. invertrows
4. invertcols
5. transpose

ImportFileCSV

ImportFileCSV('filename', readrows=False, dsprefix='', dssuffix='', linked=False, encoding='utf_8', renames={})

This command imports data from a CSV format file. Data are read from the file using the dataset names given at the top of the files in columns. Please see the reading data section of this manual for more information. dsprefix is prepended to each dataset name and dssuffix is added (the prefix option is deprecated and also addeds an underscore to the dataset name). linked specifies whether the data will be linked to the file. renames, if set, provides new names for datasets after import.

ImportFileHDF5

ImportFileHDF5(filename, items, namemap={}, slices={}, twodranges={}, twod_as_oned=set([]), convert_datetime={}, prefix='', suffix='', renames={}, linked=False)

Import data from a HDF5 file. items is a list of groups and datasets which can be imported. If a group is imported, all child datasets are imported. namemap maps an input dataset to a veusz dataset name. Special suffixes can be used on the veusz dataset name to indicate that the dataset should be imported specially.

```
'foo (+)': import as +ve error for dataset foo
'foo (-)': import as -ve error for dataset foo
'foo (+-)': import as symmetric error for dataset foo
```

slices is an optional dict specifying slices to be selected when importing. For each dataset to be sliced, provide a tuple of values, one for each dimension. The values should be a single integer to select that index, or a tuple (start, stop, step), where the entries are integers or None.

twodranges is an optional dict giving data ranges for 2d datasets. It maps names to (minx, miny, maxx, maxy). twod_as_oned: optional set containing 2d datasets to attempt to read as 1d

convert_datetime should be a dict mapping hdf name to specify date/time importing. For a 1d numeric dataset: if this is set to 'veusz', this is the number of seconds since 2009-01-01, if this is set to 'unix', this is the number of seconds since 1970-01-01. For a text dataset, this should give the format of the date/time, e.g. 'YYYY-MM-DD|T|hh:mm:ss' or 'iso' for iso format.

renames is a dict mapping old to new dataset names, to be renamed after importing. linked specifies that the dataset is linked to the file.

```
    Attributes can be used in datasets to override defaults:
     'vsz_name': set to override name for dataset in veusz
     'vsz_slice': slice on importing (use format "start:stop:step,...")
     'vsz_range': should be 4 item array to specify x and y ranges:
                  [minx, miny, maxx, maxy]
     'vsz_twod_as_oned': treat 2d dataset as 1d dataset with errors
     'vsz_convert_datetime': treat as date/time, set to one of the values
                             above.
```

For compound datasets these attributes can be given on a per-column basis using attribute names vsz_attributename_columnname.

Returns: list of imported datasets

ImportFilePlugin

ImportFilePlugin('pluginname', 'filename', **pluginargs, linked=False, encoding='utf_8', prefix='', suffix='', renames={})

Import data from file using import plugin 'pluginname'. The arguments to the plugin are given, plus optionally a text encoding, and prefix and suffix to prepend or append to dataset names. renames, if set, provides new names for datasets after import.

ImportFITSFile

ImportFITSFile(datasetname, filename, hdu, datacol='A', symerrcol='B', poserrcol='C', negerrcol='D', linked=True/False, renames={})

This command does a simple import from a FITS file. The FITS format is used within the astronomical community to transport binary data. For a more powerful FITS interface, you can use PyFITS within your scripts.

The datasetname is the name of the dataset to import, the filename is the name of the FITS file to import from. The hdu parameter specifies the HDU to import data from (numerical or a name).

If the HDU specified is a primary HDU or image extension, then a two-dimensional dataset is loaded from the file. The optional parameters (other than linked) are ignored. Any WCS information within the HDU are used to provide a suitable xrange and yrange.

If the HDU is a table, then the datacol parameter must be specified (and optionally symerrcol, poserrcol and negerrcol). The dataset is read in from the named column in the table. Any errors are read in from the other specified columns.

If linked is True, then the dataset is not saved with a saved document, but is reread from the data file each time the document is loaded. renames, if set, provides new names for datasets after import.

ImportString

ImportString('descriptor', 'data')

Like, ImportFile, but loads the data from the specfied string rather than a file. This allows data to be easily embedded within a document. The data string is usually a multi-line Python string.

Returns: A tuple containing a list of the imported datasets and the number of conversions which failed for a dataset.

Changed in version 0.5: A tuple is returned rather than just the number of imported variables.

```
ImportString('x y', '''
1   2
2   5
3   10
''')
```

ImportString2D

ImportString2D(datasets, string)

Imports a two-dimensional dataset from the string given. This is similar to the ImportFile2D command, with the same dataset format within the string. This command, however, does not currently take any optional parameters. The various controlling parameters can be set within the string. See the ImportFile2D section for details.

IsClosed

IsClosed()

Returns a boolean value telling the caller whether the plotting window has been closed.

Note: this command is only supported in the embedding interface.

List

List(where='.')

List the widgets which are contained within the widget with the path given, the type of widgets, and a brief description.

Load

Load('filename.vsz')

Loads the veusz script file given. The script file can be any Python code. The code is executed using the Veusz interpreter.

Note: this command is only supported at the command line and not in a script. Scripts may use the python **execfile** function instead.

MoveToPage

MoveToPage(pagenum)

Updates window to show the page number given of the document.

Note: this command is only supported in the embedding interface or veusz_listen.

ReloadData

ReloadData()

Reload any datasets which have been linked to files.

Returns: A tuple containing a list of the imported datasets and the number of conversions which failed for a dataset.

Rename

Remove('widgetpath', 'newname')

Rename the widget at the path given to a new name. This command does not move widgets. See To for a description of the path syntax. '.' can be used to select the current widget.

Remove

Remove('widgetpath')

Remove the widget selected using the path. See To for a description of the path syntax.

ResizeWindow

ResizeWindow(width, height)

Resizes window to be width by height pixels.

Note: this command is only supported in the embedding interface or veusz_listen.

Save

Save('filename.vsz')

Save the current document under the filename given.

Set

Set('settingpath', val)

Set the setting given by the path to the value given. If the type of **val** is incorrect, an **InvalidType** exception is thrown. The path to the setting is the optional path to the widget the setting is contained within, an optional subsetting specifier, and the setting itself.

```
Set('page1/graph1/x/min', -10.)
```

SetAntiAliasing

SetAntiAliasing(on)

Enable or disable anti aliasing in the plot window, replotting the image.

SetData

SetData(name, val, symerr=None, negerr=None, poserr=None)

Set the dataset name with the values given. If None is given for an item, it will be left blank. val is the actual data, symerr are the symmetric errors, negerr and poserr and the getative and positive asymmetric errors. The data can be given as lists or numpys.

SetDataExpression

SetDataExpression(name, val, symerr=None, negerr=None, poserr=None, linked=False, parametric=None)

Create a new dataset based on the expressions given. The expressions are Python syntax expressions based on existing datasets.

If linked is True, the dataset will change as the datasets in the expressions change.

Parametric can be set to a tuple of (minval, maxval, numitems). **t** in the expression will iterate from minval to maxval in numitems values.

SetDataRange

SetDataRange(name, numsteps, val, symerr=None, negerr=None, poserr=None, linked=False)

Set dataset to be a range of values with numsteps steps. val is tuple made up of (minimum value, maximum value). symerr, negerr and poserr are optional tuples for the error bars.

If linked is True, the dataset can be saved in a document as a SetDataRange, otherwise it is expanded to the values which would make it up.

SetData2D

SetData2D('name', val, xrange=(A,B), yrange=(C,D), xgrid=[1,2,3...], ygrid=[4,5,6...])

Creates a two-dimensional dataset with the name given. val is either a two-dimensional numpy array, or is a list of lists, with each list in the list representing a row. Do not give xrange if xgrid is set and do not give yrange if ygrid is set, and vice versa.

xrange and yrange are optional tuples giving the inclusive range of the X and Y coordinates of the data. xgrid and ygrid are optional lists, tuples or arrays which give the coordinates of the edges of the pixels. There should be one more item in each array than pixels.

SetData2DExpression

SetData2DExpression('name', expr, linked=False)

Create a 2D dataset based on expressions. name is the new dataset name expr is an expression which should return a 2D array linked specifies whether to permanently link the dataset to the expressions.

SetData2DExpressionXYZ

SetData2DExpressionXYZ('name', 'xexpr', 'yexpr', 'zexpr', linked=False)

Create a 2D dataset based on three 1D expressions. The x, y expressions need to evaluate to a grid of x, y points, with the z expression as the 2D value at that point. Currently only linear fixed grids are supported. This function is intended to convert calculations or measurements at fixed points into a 2D dataset easily. Missing values are filled with NaN.

SetData2DXYFunc

SetData2DXYFunc('name', xstep, ystep, 'expr', linked=False)

Construct a 2D dataset using a mathematical expression of "x" and "y". The x values are specified as (min, max, step) in xstep as a tuple, the y values similarly. If linked remains as False, then a real 2D dataset is created, where values can be modified and the data are stored in the saved file.

SetDataDateTime

SetDataDateTime('name', vals)

Creates a datetime dataset of name given. vals is a list of Python datetime objects.

SetDataText

SetDataText(name, val)

Set the text dataset name with the values given. **val** must be a type that can be converted into a Python list.

```
SetDataText('mylabel', ['oranges', 'apples', 'pears', 'spam'])
```

SetToReference

SetToReference(setting, refval)

Set setting to match other setting refval always..

SetUpdateInterval

SetUpdateInterval(interval)

Tells window to update every interval milliseconds at most. The value 0 disables updates until this function is called with a non-zero. The value -1 tells Veusz to update the window every time the document has changed. This will make things slow if repeated changes are made to the document. Disabling updates and using the ForceUpdate command will allow the user to control updates directly.

Note: this command is only supported in the embedding interface or veusz_listen.

SetVerbose

SetVerbose(v=True)

If **v** is **True**, then extra information is printed out by commands.

StartSecondView

StartSecondView(name = 'window title')

In the embedding interface, this method will open a new Embedding interface onto the same document, returning the object. This new window provides a second view onto the document. It can, for instance, show a different page to the primary view. name is a window title for the new window.

Note: this command is only supported in the embedding interface.

TagDatasets

TagDatasets('tag', ['ds1', 'ds2'...])

Adds the tag to the list of datasets given..

To

To('widgetpath')

The To command takes a path to a widget and moves to that widget. For example, this may be "/", the root widget, "graph1", "/page1/graph1/x", "../x". The syntax is designed to mimic Unix paths for files. "/" represents the base widget (where the pages reside), and ".." represents the widget next up the tree.

Quit

Quit()

Quits Veusz. This is only supported in veusz_listen.

WaitForClose

WaitForClose()

Wait until the plotting window has been closed.

Note: this command is only supported in the embedding interface.

Zoom

Zoom(factor)

Sets the plot zoom factor, relative to a 1:1 scaling. factor can also be "width", "height" or "page", to zoom to the page width, height or page, respectively.

This is only supported in embedded mode or veusz_listen.

Security

With the 1.0 release of Veusz, input scripts and expressions are checked for possible security risks. Only a limited subset of Python functionality is allowed, or a dialog box is opened allowing the user to cancel the operation. Specifically you cannot import modules, get attributes of Python objects, access globals() or locals() or do any sort of file reading or manipulation. Basically anything which might break in Veusz or modify a system is not supported. In addition internal Veusz functions which can modify a system are also warned against, specifically Print(), Save() and Export().

If you are running your own scripts and do not want to be bothered by these dialogs, you can run veusz with the **--unsafe-mode** option.

Chapter 4. Using Veusz from other programs

Non-Qt Python programs

Veusz can be used as a Python module for plotting data. There are two ways to use the module: (1) with an older path-based Veusz commands, used in Veusz saved document files or (2) using an object-oriented interface. With the old style method the user uses a unix-path inspired API to navigate the widget tree and add or manipulate widgets. With the new style interface, the user navigates the tree with attributes of the `Root` object to access Nodes. The new interface is likely to be easier to use unless you are directly translating saved files.

Older path-based interface

```
"""An example embedding program. Veusz needs to be installed into
the Python path for this to work (use setup.py)

This animates a sin plot, then finishes
"""

import time
import numpy
import veusz.embed as veusz

# construct a Veusz embedded window
# many of these can be opened at any time
g = veusz.Embedded('window title')
g.EnableToolbar()

# construct the plot
g.To( g.Add('page') )
g.To( g.Add('graph') )
g.Add('xy', marker='tiehorz', MarkerFill__color='green')

# this stops intelligent axis extending
g.Set('x/autoExtend', False)
g.Set('x/autoExtendZero', False)

# zoom out
g.Zoom(0.8)

# loop, changing the values of the x and y datasets
for i in range(10):
    x = numpy.arange(0+i/2., 7.+i/2., 0.05)
    y = numpy.sin(x)
    g.SetData('x', x)
    g.SetData('y', y)

    # wait to animate the graph
    time.sleep(2)
```

```
# let the user see the final result
print "Waiting for 10 seconds"
time.sleep(10)
print "Done!"

# close the window (this is not strictly necessary)
g.Close()
```

The embed interface has the methods listed in the command line interface listed in the Veusz manual http://home.gna.org/veusz/docs/manual.html

Multiple Windows are supported by creating more than one `Embedded` object. Other useful methods include:

- `WaitForClose()` - wait until window has closed
- `GetClick()` - return a list of `(axis, value)` tuples where the user clicks on a graph
- `ResizeWndow(width, height)` - resize window to be `width` x `height` pixels
- `SetUpdateInterval(interval)` - set update interval in ms or 0 to disable
- `MoveToPage(page)` - display page given (starting from 1)
- `IsClosed()` - has the page been closed
- `Zoom(factor)` - set zoom level (float) or 'page', 'width', 'height'
- `Close()` - close window
- `SetAntiAliasing(enable)` - enable or disable antialiasing
- `EnableToolbar(enable=True)` - enable plot toolbar
- `StartSecondView(name='Veusz')` - start a second view onto the document of the current `Embedded` object. Returns a new `Embedded` object.

New-style object interface

In versions of Veusz >1.8 is a new style of object interface, which makes it easier to construct the widget tree. Each widget, group of settings or setting is stored as a Node object, or its subclass, in a tree. The root document widget can be accessed with the `Root` object. The dot operator "." finds children inside other nodes. In Veusz some widgets can contain other widgets (Root, pages, graphs, grids). Widgets contain setting nodes, accessed as attributes. Widgets can also contain groups of settings, again accessed as attributes.

An example tree for a document (not complete) might look like this

```
Root
\-- page1                    (page widget)
    \-- graph1               (graph widget)
        \--  x               (axis widget)
        \--  y               (axis widget)
        \-- function         (function widget)
    \-- grid1                (grid widget)
        \-- graph2           (graph widget)
            \-- xy1          (xy widget)
```

```
            \-- xData     (setting)
            \-- yData     (setting)
            \-- PlotLine  (setting group)
                \-- width (setting)
                ...
            ...
        \-- x             (axis widget)
        \-- y             (axis widget)
    \-- graph3            (graph widget)
        \-- contour1      (contour widget)
        \-- x             (axis widget)
        \-- y             (axis widget)
```

Here the user could access the xData setting node of the xy1 widget using `Root.page1.graph2.xy1.xData`. To actually read or modify the value of a setting, you should get or set the `val` property of the setting node. The line width could be changed like this

```
graph = embed.Root.page1.graph2
graph.xy1.PlotLine.width.val = '2pt'
```

For instance, this constructs a simple x-squared plot which changes to x-cubed:

```
import veusz.embed as veusz
import time

#  open a new window and return a new Embedded object
embed = veusz.Embedded('window title')
#  make a new page, but adding a page widget to the root widget
page = embed.Root.Add('page')
#  add a new graph widget to the page
graph = page.Add('graph')
#  add a function widget to the graph. The Add() method can take a list of settings
#  to set after widget creation. Here, "function='x**2'" is equivalent to
#  function.function.val = 'x**2'
function = graph.Add('function', function='x**2')

time.sleep(2)
function.function.val = 'x**3'
#  this is the same if the widgets have the default names
Root.page1.graph1.function1.function.val = 'x**3'
```

If the document contains a page called "page1" then `Root.page1` is the object representing the page. Similarly, `Root.page1.graph1` is a graph called `graph1` in the page. You can also use dictionary-style indexing to get child widgets, e.g. Root['page1']['graph1']. This style is easier to use if the names of widgets contain spaces or if widget names shadow methods or properties of the Node object, i.e. if you do not control the widget names.

Widget nodes can contain as children other widgets, groups of settings, or settings. Groups of settings can contain child settings. Settings cannot contain other nodes. Here are the useful operations of Nodes:

```
class Node(object):
```

```
  """properties:
    path - return path to object in document, e.g. /page1/graph1/function1
    type - type of node: "widget", "settinggroup" or "setting"
    name - name of this node, e.g. "graph1"
    children - a generator to return all the child Nodes of this Node, e.g.
      for c in Root.children:
        print c.path
    children_widgets - generator to return child widget Nodes of this Node
    children_settinggroups - generator for child setting groups of this Node
    children_settings - a generator to get the child settings
    childnames - return a list of the names of the children of this Node
    childnames_widgets - return a list of the names of the child widgets
    childnames_settinggroups - return a list of the names of the setting groups
    childnames_settings - return a list of the names of the settings
    parent - return the Node corresponding to the parent widget of this Node

    __getattr__ - get a child Node with name given, e.g. Root.page1
    __getitem__ - get a child Node with name given, e.g. Root['page1']
  """

  def fromPath(self, path):
     """Returns a new Node corresponding to the path given, e.g. '/page1/graph1'"""

class SettingNode(Node):
    """A node which corresponds to a setting. Extra properties:
    val - get or set the setting value corresponding to this value, e.g.
     Root.page1.graph1.leftMargin.val = '2cm'
    """

class SettingGroupNode(Node):
    """A node corresponding to a setting group. No extra properties."""

class WidgetNode(Node):
    """A node corresponding to a widget.

       property:
         widgettype - get Veusz type of widget

       Methods are below."""

    def WalkWidgets(self, widgettype=None):
        """Generator to walk widget tree and get widgets below this
        WidgetNode of type given.

        widgettype is a Veusz widget type name or None to get all
        widgets."""

    def Add(self, widgettype, *args, **args_opt):
        """Add a widget of the type given, returning the Node instance.
        """

    def Rename(self, newname):
        """Renames widget to name given.
        Existing Nodes corresponding to children are no longer valid."""
```

```
    def Action(self, action):
        """Applies action on widget."""

    def Remove(self):
        """Removes a widget and its children.
        Existing Nodes corresponding to children are no longer valid."""
```

Note that Nodes are temporary objects which are created on the fly. A real widget in Veusz can have several different WidgetNode objects. The operators == and != can test whether a Node points to the same widget, setting or setting group.

Here is an example to set all functions in the document to be `x**2`:

```
for n in Root.WalkWidgets(widgettype='function'):
  n.function.val = 'x**2'
```

Translating old to new style

Here is an example how you might translate the old to new style interface (this is taken from the `sin.vsz` example).

```
# old (from saved document file)
Add('page', name='page1')
To('page1')
Add('graph', name='graph1', autoadd=False)
To('graph1')
Add('axis', name='x')
To('x')
Set('label', '\\italic{x}')
To('..')
Add('axis', name='y')
To('y')
Set('label', 'sin \\italic{x}')
Set('direction', 'vertical')
To('..')
Add('xy', name='xy1')
To('xy1')
Set('MarkerFill/color', 'cyan')
To('..')
Add('function', name='function1')
To('function1')
Set('function', 'sin(x)')
Set('Line/color', 'red')
To('..')
To('..')
To('..')



# new (in python)
import veusz.embed
```

```
embed = veusz.embed.Embedded('window title')

page = embed.Root.Add('page')
# note: autoAdd=False stops graph automatically adding own axes (used in saved files)
graph = page.Add('graph', autoadd=False)
x = graph.Add('axis', name='x')
x.label.val = '\\italic{x}'
y = graph.Add('axis', name='y')
y.direction.val = 'vertical'
xy = graph.Add('xy')
xy.MarkerFill.color.val = 'cyan'
func = graph.Add('function')
func.function.val = 'sin(x)'
func.Line.color.val = 'red'
```

PyQt4 programs

There is no direct PyQt4 interface. The standard embedding interface should work, however.

Non Python programs

Support for non Python programs is available in a limited form. External programs may execute the **veusz_listen** executable or **veusz_listen.py** Python module. Veusz will read its input from the standard input, and write output to standard output. This is a full Python execution environment, and supports all the scripting commands mentioned in Commands, a **Quit()** command, the **EnableToolbar()** and the **Zoom(factor)** command listed above. Only one window is supported at once, but many **veusz_listen** programs may be started.

veusz_listen may be used from the shell command line by doing something like:

```
veusz_listen < in.vsz
```

where **in.vsz** contains:

```
To(Add('page') )
To(Add('graph') )
SetData('x', arange(20))
SetData('y', arange(20)**2)
Add('xy')
Zoom(0.5)
Export("foo.eps")
Quit()
```

A program may interface with Veusz in this way by using the **popen** C Unix function, which allows a program to be started having control of its standard input and output. Veusz can then be controlled by writing commands to an input pipe.

C, C++ and Fortran

A callable library interface to Veusz is on my todo list for C, C++ and Fortran. Please tell me if you would be interested in this option.